REMARKS

Status of this application

In the Office Action mailed on February 5, 2005, claims 14-20 were rejected as being indefinite due to missing clause in independent claim 14. Claims 1-20 were also finally rejected as being directed to subject matter deemed by the Examiner to be obvious in view of Kim et al. Patent 6,040,936 either taken singly or in combination with other references as shown in the table below:

Claims	Basis	Reference(s)
1-6, 8 and 21-25	§103(a)	Kim et al. Patent 6,040,936
7, 9-13 and 26	§103(a)	Kim et al. Patent 6,040,936 + Thio Patent 6,441,298
14-20	§103(a)	Kim et al. Patent 6,040,936 + Ebbesen et al. Patent 6,236,030

This Response

This Amendment is being submitted with a Request for Continued Examination. It is requested that the finality of the outstanding action be withdrawn and that this amendment be entered and considered as provided by 37 C.F.R. §114(d)

This response amends claim 14 to add a final clause which was inadvertently omitted in the last amendment. This correction is believed to correct the indefiniteness noted by the Examiner.

This response further requests reconsideration of the remaining rejections based on "obviousness" for the reasons presented below. For convenience, the following presentation begins with a brief summary of applicant's invention as claimed and the system disclosed in the cited Kim et al. Patent 6,040,936.

The Applicant's Invention

Applicant's invention as claimed illuminates a target with an extremely small spot of light. A light source illuminates an electrically conductive surface formed on one face of a light barrier and the light from the source passes through one or more sub-wavelength sized apertures through the light barrier to the target positioned near the exit of the aperture at the opposing

surface of the light barrier. The small spot size is achieved by employing a light barrier that consists of the combination of an opaque dielectric which is covered by a conductive layer on the surface exposed to incident light from the source. The addition of the opaque dielectric confines the extent of electronic excitation induced in the second surface to that portion of the second surface that is near each aperture. A variety of different embodiments of the invention are disclosed and claimed which utilize different structures to confine the electronic excitation on the exit surface to a region close to the aperture.

The Cited Kim et al. Patent 6,040,936

Kim et al. also employ a light barrier which includes a thin, perforated metal film having a conductive surface exposed to a light source. The light from the source passes through each of an array of sub-wavelength sized apertures through the film. In the Kim et al. arrangement, as in applicant's invention, an array of apertures is preferably used to enhance the amount of light transmitted through the apertures.

In the cited Kim et al. Patent 6,040,936, the perforated metal film is placed adjacent to a transparent dielectric support layer which exhibits a selectively variable refractive index. By varying the refractive index of the adjacent support layer, Kim et al. modulate the intensity of the light passing transparent layer.

The cited Kim et al. Patent is not concerned with, and does not teach, any mechanism for restricting the illumination spot size created by the light passing through the apertures. Kim et al. do not describe any mechanism or method for confining the extent of the electronic excitation induced in the exit surface to that portion of the exit surface that is near each aperture, nor do Kim et al. suggest or describe any reason for confining the excitation to a portion of the exit surface near each aperture. Moreover, Kim et al. do not suggest or disclose a light barrier comprising the combination of a conductive layer and an opaque dielectric wherein the sub wavelength apertures pass through both the conductive layer and the opaque dielectric.

Claim Rejections – 35 USC §103

Claims 1-20 were finally rejected as being directed to subject matter deemed by the Examiner to be obvious in view of Kim et al. Patent 6,040,936 either taken singly or in combination with other references. Reconsideration of this rejection is respectfully requested in

view of the amendments which have been made to the claims and in view of the following remarks.

In this response, claim 1 has been amended to incorporate the limitations of claims 2 and 3. As amended, claim 1 sets forth a specific planar light barrier structure interposed between a radiation source and a target, the light barrier comprising the combination of a layer of conductive metal at the surface exposed to incident radiation and barrier material having significantly different dielectric properties that is opaque to the radiation placed between the metal layer and the second surface. As clearly set forth in claim 1, one or more sub-wavelength apertures pass through both the metal layer and the barrier material.

The Examiner concedes that Kim et al. do not "explicitly state means for confining the extent of the electronic excitation induced in the second surface to the portion of the second surface that is near each of the apertures" but contends that the placement of a dielectric material near the aperture exit inherently confines the extent of excitation to a portion of the surface near each aperture. Specifically, with respect to claim 1, the Examiner stated:

> *". . . it is the examiner' view that Kim [936] does teach/provide means for confining the extent of the electronic excitation induced in the second surface to the portion of the second surface that is near each of the apertures. This is made evident by Kim [936] teaching varying the refractive index between the surfaces, and inserting air or another dielectric material adjacent the second surface. Since it is known that inserting a dielectric adjacent the metal surface will aid in confining the electronic excitation, it is the examiner's view that the insertion of dielectric/air between the metal layer and the support layer mentioned in Kim [936] col. 5 lines 44-68, would in fact confine the excitation to the area near the aperture exits. See Kim [936] figs. 1-2B, 8, 11-13B, columns 1-2, col. 5, lines 44-68, col. 6 lines 1-7, col. 8 line 14-50, col. 10 lines 15-35, 50-55, col. 12 lines 23-55 and col. 18 lines 1-5. In fact, the applicant teaches this structure being used to achieve the effect of confining the electronic excitation to the second surface. See applicants' specification, page 8 paragraphs 3-4, page 9 paragraphs 4, and the continuing paragraph at the top of page 10."*

Kim et al. do disclose sub-wavelength apertures through a perforated metal film 102 that is placed in direct contact with a transparent liquid crystal cell (a dielectric), but Kim et al's dielectric is not perforated, and is not opaque to the radiation, but is explicitly taught to be a transparent material that exhibits a variable refractive index to modulate the amount of light passing therethrough.

It is submitted, that this structure is totally unlike the apparatus set forth in claim 1 as amended, both in structure and in function. First, claim 1 makes it clear that the light barrier comprises a metal layer and a barrier material having significantly different dielectric properties that is opaque to light, and that the sub wavelength apertures pass through both the metal layer and the opaque barrier material. The LCD Cell taught by Kim et al. is not opaque to light and the sub wavelength apertures do not pass through it. The perforated metal film is the only structure taught by Kim et al. through which the sub wavelength apertures pass, but this metal film clearly does not consist of the combination of a metal layer and a barrier material having significantly different dielectric properties as set forth in claim 1.

The express limitation set forth in claim 1 which Kim et al. fail to suggest or disclose play an important role in achieving the objective of applicants' invention; namely, directing a small area of illumination onto a target. The fact that the barrier material is opaque to radiation and has a dielectric constant significantly different from that of the metal film confines the excitation of induced in the exit surface to that portion of the exit surface that is near each aperture. Because applicants' barrier material is opaque to radiation, the sub wavelength aperture(s) must pass through both it and the metal layer in order for the desired illumination to pass to the target.

The limitations originally presented in claims 2 and 3 have been incorporated into parent claim 1, and claims 2 and 3 have accordingly been canceled.

With respect to claim 4, the Examiner concedes that Kim et al. do not disclose a layer of conductive material that extends into the interior sidewalls of each aperture terminating at the second surface of the barrier in a limited area in the vicinity of each aperture. The Examiner suggests that such a structure would be obvious in view of the Kim et al. patent's teaching, citing column 1, lines 1-30 and column 4, lines 60-67. But both of these passages deal with thin perforated films of solid metal. There is nothing in either passage to suggest either a structure consisting of a layer of conductive material on the sidewalls of the aperture which terminates in a

limited area in the vicinity of each aperture as claimed, nor is there any recognition in the cited passages of the reason for creating such a structure (i.e., limiting the spot size of the illumination on a nearby target by confining the excitation at the exit surface to the vicinity of the apertures). Nothing in either cited passage suggests anything other than a solid metal film which does not confine the electronic excitation induced in the second surface to a limited conductive area near each aperture as claimed. One skilled in the art would not substitute an opaque dielectric for the transparent dielectric taught by Kim et al., because it is essential to the operation of the Kim et al. light modulator that the light pass through a transparent dielectric having a variable refractive index. One skilled in the art would similarly not pass the sub wavelength apertures through both the perforated metal film and the transparent dielectric because to do so would prevent the dielectric from acting as a light modulator as intended.

Claim 5 as amended sets forth a confined annular conductive area that surrounds each aperture to confine the excitation to the vicinity of each aperture. Claim 5 as amended thus further distinguishes applicant's invention from Kim et al. because the conductive transparent layer 117 of Kim et al. cited by the Examiner overlays the entire LCD cell of Kim et al. and is not an annular area surrounding each aperture as claimed.

Claim 6, rejected solely because it was dependent on a rejected claim, sets forth a conductive layer positioned at the second surface and a groove in this conductive layer which surrounds each aperture to define a confined conductive area. No such structure of function is disclosed or suggested by Kim et al.

Claim 7, which has been amended to be dependent upon amended claim 1 rather than canceled claim 2, states that the barrier material is a dielectric that has a bandgap greater than the frequency of the radiation. Kim et al. teach placing a transparent dielectric having a variable refractive index in contact with a perforated metal film but this dielectric is not opaque to radiation and the apertures through the metal film do not also pass through the variable refractive index dielectric. Accordingly, for the same reasons set forth with respect to claim 1, claim 7 is believed to clearly distinguish over the Kim et al. reference.

In rejecting claim 8 which is directed to a light barrier consisting of two different metals having different resonances, the Examiner points to the multiple layers of the Kim et al. light control apparatus and suggests that these could be formed of different metals. However, as noted above, claim 1 requires that the apertures pass through the entire light barrier, and the only thing

the apertures pass through in the Kim et al. arrangement is a single metal film. There is nothing in Kim et al. which would suggest that the light barrier through which the apertures pass be constructed of two metals, and more particularly two metals having significantly different dielectric properties and different resonances in order to confine the electronic excitation at the exit surface to the vicinity of each aperture exit. Reconsideration of the rejection of claim 8 is accordingly requested.

Claim 9, like canceled claim 3, has been canceled since it set forth limitations which have now been incorporated into it parent claim 1 as amended.

Claim 10 is believed to be allowable for the reasons set forth above with respect to claim 4.

Claims 11 has been amended to set forth a confined annular conductive area that surrounds each aperture and is believed to be allowable for the reasons set forth above with respect to claim 5.

Claim 12 was rejected solely because it was dependent on a rejected claim and is believed to be allowable.

Claim 13 is believed to be allowable for the reasons set forth above with respect to claim 8.

Independent claim 14 has been amended to correct the indefiniteness objected to by the Examiner and to more clearly distinguish applicants' invention from the light modulation device described by Kim et al. Claim 14 clearly defines a light barrier consisting of the combination of an <u>opaque dielectric</u> and a conductive layer of metal affixed to the dielectric, with sub-wavelength apertures passing through <u>both</u> the dielectric and the layer of metal. As discussed above, the sub wavelength apertures described by Kim et al. pass through a perforated metal film only, and do not pass through the dielectric used as a light modulator. Moreover, as discussed above, this dielectric is used as light modulator and is not opaque but necessarily transparent. Accordingly, claim 14 and its dependent claims 15-20 are believed to be allowable for the reasons presented above with respect to claim 1 as amended.

Method Claims 21-23 have been amended to more clearly set forth that the radiation barrier through which the apertures pass comprises the combination of a metal layer and a dielectric layer that is opaque to radiation and are believed to be allowable for the reasons presented above with respect to independent claims 1 and 14.

Finally, claims 24, 25 and 26 which are dependent on claim 1 respectively state that the target upon which the desired small spot illumination is directed takes the form of an optical storage medium (claim 24), a sample viewed by the objective lens of a microscope (claim 25), or a photoresist exposed during a lithographic process (claim 26). The targets set forth in claims 24-26 are used in systems which benefit from the small spot size produced by the novel light barrier structure defined in claim 1. Because the Kim et al. light control apparatus is not concerned with reducing the spot size of the illumination produced at the exit of the apertures from the light barrier, the combination of the Kim et al. structure and these targets would not yield the results obtained by these applications of applicant's invention; namely, increased storage density in an optical storage medium; increased resolution for microscopy; and increased resolution and throughput for lithography. It is submitted that combinations claimed for providing these benefits are neither disclosed nor suggested by the Kim et al. patent. This is not to suggest that the desirability of achieving small spot sizes for such applications is not well known; rather, it is submitted that the cited Kim et. al patent does not suggest the structures claimed by applicant for reducing the spot size produced by sub-wavelength apertures.

The rejections based on combinations of references

Claims 7, 9-13 and 26 were rejected under §103(a) based on Kim et al. Patent 6,040,936 when considered in view of Thio Patent 6,441,298.

Claim 7 and its dependent claims 9-13 require the presence of a barrier material that is (1) a dielectric and (2) that exhibits a bandgap that is larger than the frequency of the electromagnetic radiation forms part of the light barrier through which the apertures pass. The Examiner cites column 7, lines 60-65 and column 1, lines 35-40 and 60-67 of the Kim et al. patent which state that the perforated metal film must be optically thick (opaque to light) and are adjacent to a dielectric medium. Nothing in the cited passages of the Kim et al. patent suggests that the perforated light barrier itself, through which the apertures pass, should include a dielectric material.

The Examiner further cites column 6, lines 5-30 of the Thio patent which describes a photovoltaic cell in which spherical semiconductor devices are positioned at the light exit of each aperture through an illuminated thin metal film. The Thio patent indicates that the excitation spectrum of the spherical semiconductor device is determined in part by the bandgap of the

semiconductor. This teaching does not suggest that the disclosed perforated thin metal film should be replaced with the combination of a metal film and a dielectric which should have a bandgap greater than the frequency the radiation.

It is accordingly submitted that the combination defined by claims 7 and its dependent claims 9-13 is neither disclosed nor suggested by either the Kim et al or Thio references.

With respect to claim 26, which is dependent on claim 1 and defines the target which receives the small spot illumination as being a photoresist in a lithographic process, the Examiner cites Theo at column 3, lines 10-30 and column 9, lines 1-11 which deal with lithographic methods for fabricating the photovoltaic cell structures described. This teaching says nothing about the use of the claimed novel light barrier configurations which concentrate light into small spot sizes by confining the area of surface excitation to a region near the exit of the sub-wavelength apertures through the light barrier. Instead, it is merely a description of the use of lithography in the fabrication of small semiconductor structures. Reconsideration of the rejection of claim 26 based on the combined teachings of Kim et al. and Thio is accordingly requested.

Claim 14 and its dependent claims 15-20 were rejected as being unpatentable §103(a) in view of Kim et al. Patent 6,040,936 considered in view of Ebbesen et al. Patent 6,236,030. As noted above, claim 14 has been amended to clarify the fact that the sub-wavelength width apertures pass through the combination of a conductive metal layer at the illuminated surface and an opaque dielectric radiation barrier. For the reasons presented with respect to claim 1, this structure is nowhere suggested by the Kim et al. patent. The cited Ebbesen patent 6,236,033 teaches the use of a perforated metal film which further includes surface indentations or other surface topography features which enhance the transmission of light through the apertures. Ebbesen does not, however, disclose or suggest a structure which defines a confined conductive area in the vicinity of each of said apertures at the exit surface to reduce the area of area of illumination on a target. Ebbesen's light barrier is a metal film with raised or recessed grooves or dimples which enhance light transmission through the apertures through the film. Neither Ebbesen nor Kim et al., whether considered alone or together, suggest the claimed combination set forth in claims 14-20 of a conductive metal layer on the illuminated surface of a dielectric radiation barrier that is opaque to the transmitted radiation, with apertures through the conductive layer and the dielectric radiation barrier, and a confined conductive area in the vicinity of each

apertures at the exit surface which reduces the area of area of illumination on a target.

Conclusion

It is submitted that claims 1, 4-8 and 10-26 as amended by this response clearly distinguish over and represent invention over the cited references. Allowance of these claims as now presented is accordingly requested.

Respectfully submitted,

Dated: June 6, 2004

Charles G. Call, Reg. 20,406

Certificate of Transmission under 37 CFR 1.8

I hereby certify that this *Amendment* is being transmitted by facsimile to the Commissioner for Patents at (703) 872-9306.on June 6, 2004.

Dated: June 6, 2004

Signature

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